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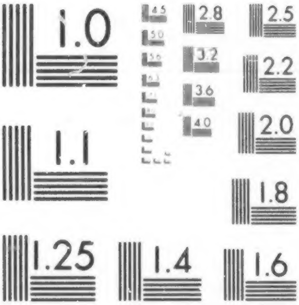
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ABSTRACT

The phonological information provided by written words may be used by the reader as a convenient temporary storage medium and as a way of gaining access to the lexicon. Beginning readers should be able to exploit the sound-based patterning of the orthography in reading single words and to bypass it on occasion. Some words do not conform to English spelling-to-sound rules and must be read by sight. This also allows for fluent reading since the reader need not stop to sound out each word. However, this strategy places an enormous burden on the child's ability to memorize word shapes. Access to the lexicon by the phonological form of a word exploits the rules governing the relationship between orthography and sound. However, for a beginning reader, application of sound-spelling rules is time consuming, and beginning readers may not have sufficient awareness of the structure of words. Some research in phonological processing by beginning readers indicates that the use they make of phonological representation differs between good and poor readers. Also, a relationship between linguistic awareness and the ability to read isolated words has been shown. Third, reading skill and experience are related to skill in accessing the phonological form of a word. (TJ)

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Phonological Coding in Beginning Reading

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A word in a spoken language has two essential properties. It has a meaning or meanings and it has a phonological form. Neither a meaningless label nor an unencoded meaning can be a word of any language.

As many investigators have pointed out, written languages are parasitic on spoken ones. Thus, the patterning of symbols in written text makes reference to some corresponding patterning in a spoken language. In alphabetic writing systems, the primary correspondence is with the meaningless sound elements of the spoken language.

Since words of a language have essential phonological as well as semantic properties, when a reader recognizes a written symbol or symbol string as a referent of a word in his language he achieves access both to the semantic and to the phonological properties constituting the word. Consequently, it may be useless to debate whether or not phonological information is accessed during reading (i.e. whether reading can be a "purely visual" process).

On the other hand, it may be useful to ask what role phonological information serves in reading. For readers of an alphabetic orthography at least two roles are possible. Of them, one is probably essential, while the other may be optional at least for skilled readers.

The essential function is to provide a convenient form for the short-term storage of textual material while it is being read. In a grammar that allows embedding, close grammatical relationships may obtain between words that are quite far apart in a sentence (e.g. "The woman who lives next door writes a column in the local newspaper"). On these grounds it has been argued that substantial portions of a sentence must be held in storage until a whole syntactic chunk is available for semantic processing. The memory system that is believed to have the requisite capacity and longevity for this purpose is phonological short-term memory.

Similarly, writers as well as talkers use pronouns in the place of common or proper nouns, but only when they can assume that the reader or listener is currently "thinking about" the pronoun's referent (e.g. Chafe, 1974). Thus, the sentence pair in 1a is natural, while that in 1b is not:

1. John broke the expensive vase. He tripped over it on his way out the door.

2. John broke the expensive vase. John tripped over the expensive vase on John's way out the door.

But pronominalization is only feasible if the reader or listener keeps old information (i.e. the information given in the first sentence of each pair) "in mind" as he processes new information. Again the likely means of keeping old textual information available is phonological short-term memory.

These considerations are supported by data from several sources. For example, skilled readers of English persist in phonological access during reading of text even when doing so impairs performance on a second task ("e-cancellation", Corcoran, 1966). Moreover, preventing phonological access during reading impairs memory for meaning (Levy, 1975). Finally, skilled readers of a logographic orthography (Chinese) code written text phonologically when their task is to read for meaning (Tzeng, Hung & Wang, 1977). These studies suggest that eventual access to phonological information (before, or at the time of lexical access) may be an invariant aspect of skilled reading across orthographies and across reading tasks that require short-term memory.

Beyond providing a convenient temporary storage medium, however, phonological information may be involved in the reading process in a second way as well. Readers of an alphabetic orthography may access the lexicon by applying spelling-to-sound rules to a written word in order to extract its corresponding phonological form. The phonological information may then serve as it does in listening as the "address" for the appropriate lexical entry. Baron and Strawson (1976) provide evidence that some skilled readers tend to use this means of word identification. Of course, the skilled reader need not access the lexicon in this way. Baron and Strawson (1976) also provide evidence that other readers habitually access the lexicon based on a word's orthographic form.

The beginning reader: The possibility of flexible processing strategies

But what of the *beginning* reader of an alphabetic orthography? What role does phonological coding serve in the beginner's efforts to read, and what role should it serve? On the one hand, the requirements of short-term memory are as critical to him as they are to the skilled reader. But what of its role in reading isolated words? Should the child exploit the sound-based patterning of the orthography in his reading of single words, or should he bypass it as some skilled readers tend to do, and as readers of logographic writing systems apparently must do?

A moment's consideration suggests that he should be *capable* of doing both. Each processing style has its special advantages and disadvantages that may suit it best for different kinds of words or for different situations in which words are to be identified.

Consider first the strategy in which lexical access is based on a word's holistic optical form, and thus in which the sound-based patterning of the orthography is irrelevant to the reading task. Some words, namely those that do not conform to English spelling-to-sound rules, must be read in this way. Moreover, an advantage of this strategy for the child may be that his reading can be more fluent than it is when he stops to sound out each word. On the other hand, at the very earliest stages of learning to read, this strategy places an enormous burden on the child's ability to rote memorize word shapes, and on his ability to make intelligent guesses based on context when he sees an unfamiliar word.

For its part, the second strategy--of accessing the lexicon based on the phonological form of a word--also has important advantages and disadvantages. Its main advantage is that it exploits the ruleful relationship between orthography and sound. Thereby it enables the child to read most of the words that he knows by sound but not yet by sight.

As important as this advantage is, it is countered somewhat by two apparent disadvantages. One is that for an unpracticed reader, application of sound-spelling rules is time consuming. Thus, reading may not be fluent, and the child may have difficulty remembering words that he has already read as he is confronted with the "interfering" task of word decoding. The second disadvantage is that this strategy requires what Mattingly calls "linguistic awareness", and similarly it requires that the child understand the relationship between aspects of the language and of the orthography. Thus, it requires that the reader be aware that words, both written and spoken have an internal structure, and that the internal structure of the one refers to (provides information about) the internal structure of the other. Recent research makes it quite clear that information about the sound structure of a spoken word or syllable is not readily available to the nonreader's awareness (Liberman, Shankweiler, Fischer & Carter, 1974). Rather the child has to learn explicitly what he already knows tacitly--namely that words are sequences of phonological segments. This is the problem of linguistic awareness. In addition, is the related problem of understanding the relationship between analogous characteristics of written and spoken words. Even seemingly obvious relationships are not obvious to the young child. For example, he may not know that orthographic length is correlated with spoken duration (Rozin, Bressman & Taft, 1974).

The foregoing considerations of the advantages and disadvantages of the two reading strategies suggest that an optimal approach to reading for a child is one in which he uses both means of lexical access but in either case, stores the outcome in phonological short-term storage. If he can recognize a word on sight, then that may be the most efficient means of access to the lexicon. Failing that, however, it is important that he have a reliable way to identify a word. The most reliable way, given the nature of the orthography, is the strategy of exploiting the ruleful relationship between the atomic units of the orthography and those of the language.

Research assessing the processing styles of beginning readers

My colleagues and I have been concerned to examine the role of phonological coding in beginning reading, both in respect to its role in the short-term storage of verbal information (Liberman, Shankweiler, Liberman, Fowler & Fischer, 1977) including text (Fowler, in preparation; Mann, Liberman, Shankweiler & Katz, in preparation) and in respect to its role in lexical access (Fowler, Liberman & Shankweiler, 1977; Mark, Shankweiler, Liberman & Fowler, 1977). We have tried to assess the importance of this linguistic aspect of reading for the beginner by comparing the effectiveness with which a reader accesses and uses phonological information to his degree of reading skill. We have devoted less effort to the visual component of the reading process primarily because the available evidence suggests that it is not a problematic aspect of learning to read even among most poor readers (e.g. Liberman & Shankweiler, in press; Vellutino, 1977). Three of the areas in which my colleagues and I have studied phonological processing in beginning reading are briefly summarized below.

Phonological coding in reading text

In any reading task that involves short-term memory --either explicitly or by implication in requiring comprehension of text--we should find that the beginning reader encodes the textual material phonologically. Moreover, given that good and poor readers do not differ strikingly on nonlinguistic aspects of the reading task, we would expect to find the differences among them to show up in the extent to which they make efficient use of the phonological representation in their reading of text.

Two results obtained by our research group bear out these predictions. In one experiment (Fowler, in preparation), second grade good and poor readers were given two tasks to be performed concurrently. They were asked to read a short passage for comprehension and at the same time to cancel out any letters "e" that they saw while reading. This task was modeled after Corcoran's original experiment designed to assess phonological coding by adult readers. He found that silent e's were missed more often than nonsilent e's and suggested that this difference could only arise if the subjects were coding the written words into some sound-based form. Our study replicated Corcoran's in showing a higher proportion of silent e's being missed by both groups of readers than nonsilent e's ($F(1,34) = 37.8$, $p < .001$). In this study, although good readers tended to show a larger silent e effect than poor readers, the difference did not approach significance.

However, in a study of immediate recall of sentences, Mann, Liberman, Shankweiler & Katz (in preparation) did obtain the expected difference between good and poor readers. In this study, good readers were substantially more impaired than were poor readers by phonological confusability among the component words of a sentence.

Linguistic awareness and beginning reading skill

Beyond the role of the phonology in comprehension and storage of text, we have suggested that phonological information may also be invoked by application of spelling-to-sound rules when individual words are read. This use of the sound-patterning of the language, as we have noted, demands "linguistic awareness" on the part of the reader. Thus we would expect to find a relationship between a child's degree of linguistic awareness and his ability to read isolated words. Several studies have obtained a significant correlation between a subject's performance on Liberman's phoneme segmenation task, designed to measure linguistic awareness, and performance on the Wide Range Achievement Test, which assesses skill in reading isolated words (Helfgott, 1976; Zifcak, 1977). Thus, subjects who perform more poorly when asked to indicate the number of phonemic segments in a word by tapping once per segment, also rank lowest on a test of isolated-word reading.

Phonological coding in the reading of isolated words by good and poor readers

If more and less skilled readers are distinguished either in the extent to which they use the phonological coding strategy of lexical access, or in the success with which they use it, the coding component in isolated-word reading might be expected to be more salient among good than among poor readers, and more salient among experienced than among less experienced readers.

A difference between good and poor readers was found in an experiment by Mark, Shankweiler, Liberman and Fowler (1977). In that study, second grade good and poor readers were given a list of words to read aloud. Following that, unexpectedly, they were given a recognition task including the words that they had just read and a set of rhyming and nonrhyming foils. Good but not poor readers made significantly more false positive responses to rhyming foils than to nonrhyming foils.

An investigation of the development of phonological coding skills provides compatible data (Fowler, Shankweiler & Liberman, 1978) in showing a relationship between skill in accessing the phonological form of a letter string and reading experience. This study showed an increase in tendency to apply spelling-to-sound rules appropriately to nonsense letter-strings with increasing reading experience among second, third and fourth grade children.

Summary

The literature on skilled reading suggests two ways in which speech coding contributes to the skilled reading process. On the one hand, phonological short-term memory facilitates the comprehension of text, and on the other hand, the phonological form of a written word may serve as the word's lexical address. Both of these services are at least as critical to the beginner as they are to the skilled reader. Our research concerning the correlates of beginning reading attests to this in showing that good and poor beginning readers, and likewise, less and more experienced readers are distinguished on measures of linguistic awareness and on several other indicants of facility with speech coding.

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